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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/805,966	03/22/2004	Vikram Singh	2003-42/43	2603
7590 Mark Superko, Esq. Varian Semiconductor Equipment Associates, Inc. 35 Dory Road Gloucester, MA 01930				
EXAMINER ALEJANDRO MULERO, LUZ L.				
ART UNIT		PAPER NUMBER		
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/805,966

Applicant(s)

SINGH ET AL.

Examiner

Luz L. Alejandro

Art Unit

1792

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 April 2009.
2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-4, 6-9, 11-16, 18-21, 24, 25, 27, 28, 30-36 and 38 is/are pending in the application.
4a) Of the above claim(s) 6 is/are withdrawn from consideration.
5) ☐ Claim(s) _____ is/are allowed.
6) ☒ Claim(s) 1-4, 7-9, 11-16, 18-21, 24-25, 27-28, 30-36, and 38 is/are rejected.
7) ☐ Claim(s) _____ is/are objected to.
8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-848)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 0509
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3, 7-8, 11, and 38 is rejected under 35 U.S.C. 102(b) as being anticipated by Kadomura, U.S. Patent 5,567,268.

Kadomura '268 shows the invention as claimed including a plasma apparatus comprising: a plasma chamber configured to receive a process gas; a radio frequency (RF) source 39 configured to generate RF current; an RF antenna unit including an active antenna 31 and a parasitic antenna 22, the active antenna surrounding the plasma chamber, including a first end electrically coupled to the RF source to receive the RF current from the RF source, and including a second end coupled to ground, the parasitic antenna surrounding the plasma chamber, wherein the parasitic antenna is not electrically coupled to the RF source; and a platen 29 configured to hold a target, wherein each antenna of the RF antenna unit resonates RF current and includes electromagnetic field that is effective to pass into the plasma chamber and that excites and ionizes the process gas to generate a plasma within the plasma chamber, the plasma comprising ions (see figs. 2-3 and their descriptions).

Concerning claims 2-3, note that the active antenna includes a horizontally-extended coil and the parasitic antenna includes a vertically-extending coil.

Regarding claim 7, note that one of the active and parasitic antennas of the RF antenna unit is a horizontally extending coil having a plurality of windings and wherein a diameter of innermost winding of the horizontally extending coil in a lateral direction is greater than a size of the target in the lateral direction.

With respect to claim 8, note that the parasitic antenna can be considered to be above and coaxial with the active antenna.

Concerning claim 11, the plasma chamber includes: a horizontal planar section 24 positioned above the platen 29; a vertical cylindrical section extending from the horizontal planar section; and a top section 21 coupled to the vertically cylindrical section.

Regarding claim 38, Kadomura '268 shows the invention as claimed including a plasma apparatus comprising: a plasma chamber configured to receive a process gas; a radio frequency (RF) source configured to generate RF current; an RF antenna unit including a horizontally-extending active antenna coil 31 and a vertically extending parasitic antenna coil 22, the horizontally-extending active antenna coil that includes a first end coupled to the RF source 39 to receive the RF current from the RF source, the vertically-extending parasitic antenna coil being without an electrical connection to a power source; and a platen 29 configured to hold a target, wherein the vertically-extending parasitic antenna coil induces an RF current into the plasma chamber and excites and ionizes a process gas so as to generate a plasma in the plasma chamber, the plasma comprising ions.

Claim 38 is rejected under 35 U.S.C. 102(b) as being anticipated by Kadomura, U.S. Patent 6,096,160.

Kadomura '160 shows the invention as claimed including a plasma apparatus comprising: a plasma chamber configured to receive a process gas; a radio frequency (RF) source configured to generate RF current; an RF antenna unit including a horizontally-extending active antenna coil 52 and a vertically extending parasitic antenna coil 53, the horizontally-extending active antenna coil that includes a first end coupled to the RF source 66 to receive the RF current from the RF source, the vertically-extending parasitic antenna coil being without an electrical connection to a power source; and a platen 59 configured to hold a target, wherein the vertically-extending parasitic antenna coil induces an RF current into the plasma chamber and excites and ionizes a process gas so as to generate a plasma in the plasma chamber, the plasma comprising ions.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein

were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Sahin et al., U.S. Patent 6,465,051.

Kadomura is applied as above but does not expressly disclose where the parasitic antenna has one of its ends grounded. Sahin et al. discloses grounding an antenna 26 during processing, for example, in order to perform a cleaning process (see fig. 1 and its description). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to allow for grounding of either of the antennas to allow for more flexibility when using the apparatus, for example, to allow for efficient cleaning of the apparatus.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Ishimaru, U.S. Patent 5,681,418.

Kadomura is applied as above but does not expressly disclose wherein at least one antenna is liquid cooled. Ishimaru discloses forming a coil 40 which flows liquid water coolant therethrough (see col. 5-lines 13-21). In view of this disclosure, it would

have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to liquid cool the antenna because in such a way overheating of the antenna can be prevented.

Claims 12-13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Collins et al., U.S. Patent 5,556,501.

Kadomura is applied as above but does not expressly disclose wherein the vertical cylindrical section is made of a high quality dielectric, and the top conductive section is made of aluminum and grounded. Collins et al. discloses wherein a vertical cylindrical section 17W is made of a dielectric, and the top conductive section 17T is made of aluminum and grounded (see fig. 1 and its description). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to comprise the vertically cylinder and top conductive section of Collins et al. because this will allow the improvement of process uniformity.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Collins et al., U.S. Patent 5,556,501, as applied to claims 12-13 and 15 above, and further in view of Fitzsimmons et al., U.S. Patent 6,626,188.

Kadomura and Collins et al. are applied as above but do not expressly disclose wherein the ceramic material is one from a list including aluminum nitride. Fitzsimmons

et al. discloses having aluminum nitride walls exposed to the plasma within the chamber (see fig. 3 and its description). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura and Collins et al. so as to form aluminum nitride in the plasma chamber because in such a way beneficial results will be produced such as the reduction of contamination.

Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Trow et al., US 5,824,607.

Kadomura '268 is applied as above but does not expressly disclose wherein the top section is liquid cooled. Trow et al. further discloses where a top conductive section of the apparatus is cooled by liquid (see col. 4-lines 40-50). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to cool by liquid because liquid is shown to be an adequate means of cooling a top conductive member of a plasma apparatus.

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Collins, U.S. Patent 5,707,486.

Kadomura is applied as above but does not expressly disclose a gas source controller for maintaining a pressure of a plasma chamber at a predetermined value. Collins discloses a controller for controlling the pressure of a plasma chamber (see col.

13-lines 6-20). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to include the controller of Collins to control the pressure of the plasma chamber because such a device would allow for greater controllability over the process performed within the apparatus.

Claims 19-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Collins et al., U.S. Patent 5,556,501.

Kadomura is applied as above but does not expressly disclose the RF source operating at a low frequency. Collins et al. discloses a RF source 31 which has a frequency in a range from 100 kHz to 100 Mhz (see col. 11-lines 25-40). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to provide the RF source of Collins et al. because this will allow for the selection of a top source which minimizes damage to sensitive devices and also provides efficient inductive coupling.

Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268.

Kadomura is applied as above but does not expressly disclose wherein each of the horizontally and vertically extending coil has a plurality of windings. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura '268 so as to construct the coils with a

plurality of windings because the particular configuration of the coils are a matter of choice which a person of ordinary skill in the art would have found obvious absent persuasive evidence that the particular configuration of the claimed coils are significant.

Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Okumura et al., US 5,888,413, Chen et al., US 6,527,912 or Becker et al., US 6,899,817.

Kadomura does not expressly disclose the claimed coil adjuster for adjusting a number of turns of the parasitic antenna. Okumura et al. discloses a coil adjuster 72/64,66/82,83/93 for adjusting the length and the number of turns of a coil (see figs. 13, 20-23 and their descriptions). Chen et al. discloses a coil adjuster 117 for adjusting the length and the number of turns of a coil (see figs. 2, 6 and 8, and their descriptions). Becker et al. discloses a coil adjuster 24/25 for adjusting the length and the number of turns of a coil (see fig. 2 and its description). In view of these disclosures, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to allow the coils to have their lengths and turns adjusted as suggested by Okumura et al., Chen et al. or Becker et al. because in such a way the plasma density can be effectively controlled and adjusted.

Claims 24-25, 27, 31, and 33-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Trow et al., US

5,824,607, Collins et al., U.S. Patent 5,556,501, and Denholm et al., U.S. Patent 5,911,832 or Tozuka, U.S. Patent 4,771,730.

Kadomura shows the invention substantially as claimed including a plasma chamber comprising: a horizontal planar section for positioning above a platen; a vertical cylindrical dielectric section 21 extending from the horizontal planar section; and a radio frequency antenna including a horizontally-extending coil 22 positioned proximate to the horizontal planar dielectric section and a vertically-extending coil 31 positioned proximate to the vertical cylindrical dielectric section, wherein one of the horizontally-extending coil and the vertically-extending coil comprises an active radio frequency antenna that is electrically coupled to an RF source and other one of the horizontally-extending coil and the vertically-extending coil comprises a parasitic antenna that is not electrically coupled to the RF source, the active radio frequency antenna and the parasitic antenna of the radio frequency antenna including radio frequency currents into the plasma chamber that excite and ionize a process gas so as to generate a plasma in the plasma chamber (see fig. 2 and its description).

Kadomura '268 does not expressly disclose a liquid cooled top conductive section. Trow et al. discloses where a top conductive section of the apparatus is cooled by liquid (see col. 4-lines 40-50). Additionally, Collins et al. discloses a plasma chamber comprising a cooled top conductive section 17T coupled to a vertical dielectric section 17W (see fig. 1 and its description). In view of these disclosures, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura so as to include a liquid cooled top conductive section

coupled to the vertical dielectric section as disclosed by Collins et al. or Trow et al., because in such a way the coupling of the plasma with the wafer will be improved while at the same time having improved controllability of the temperature of the chamber walls, and because liquid is shown to be an adequate means of cooling a top conductive member of a plasma apparatus.

Kadomura, Trow et al., and Collins et al. are applied as above but do not expressly disclose the horizontal planar section being a dielectric. Denholm et al. discloses covering an electrode with a dielectric material (see col. 3-lines 1-12). Alternatively, Tozuka also discloses covering an electrode with a dielectric material (see col. 2-lines 19-34). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura modified by Trow et al., and Collins et al. so as to include a dielectric in the horizontal planar section because in such a way damage from any potential residues can be minimized.

Concerning claim 25, note that in the apparatus of Kadomura modified by Trow et al., Collins et al., Denholm et al., and Tozuka, the top conductive section is grounded (see Collins et al. at col. 21-lines 60-67).

With respect to claim 31, note that in the apparatus of Kadomura modified by Trow et al., Collins et al., Denholm et al., and Tozuka, the horizontally extended coil is capable of being coupled to an RF source.

Regarding claims 33-34, note that the apparatus of Kadomura modified by Trow et al., Collins et al., Denholm et al., and Tozuka discloses: wherein the horizontally-

extending coil is spaced apart from the target by a first height in a vertical direction and the vertically-extending coil is spaced apart from the target by a second height in the vertical direction, the first height being less than the second height.

Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Trow et al., US 5,824,607 Collins et al., U.S. Patent 5,556,501, Denholm et al., U.S. Patent 5,911,832 or Tozuka, U.S. Patent 4,771,730 as applied to claims 24-25, 27, 31, and 33-34 above, and further in view of Sahin et al., U.S. Patent 6,465,051.

Kadomura, Trow et al., Collins et al., Denholm et al., and Tazuka are applied as above but does not expressly disclose where the parasitic antenna has one of its ends grounded. Sahin et al. discloses grounding an antenna 26 during processing, for example, in order to perform a cleaning process (see fig. 1 and its description). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura modified by Trow et al., Collins et al., and Denholm et al., or Tozuka so as to allow for grounding of either of the antennas to allow for more flexibility when using the apparatus, for example, to allow for efficient cleaning of the apparatus.

Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Trow et al., US 5,824,607 and Collins et al., U.S. Patent 5,556,501, Denholm et al., U.S. Patent 5,911,832 or Tozuka, U.S.

Patent 4,771,730 as applied to claims 24-25, 27, 31, and 33-34 above, and further in view of Ishimaru, U.S. Patent 5,681,418.

Kadomura, Trow et al., Collins et al., Denholm et al., and Tozuka are applied as above but do not expressly disclose wherein at least one antenna is liquid cooled. Ishimaru discloses forming a coil 40 which flows liquid water coolant therethrough (see col. 5-lines 13-21). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura modified by Trow et al., Collins et al. and Denholm et al., or Tozuka so as to liquid cool the antenna because in such a way overheating of the antenna can be prevented.

Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kadomura, U.S. Patent 5,567,268 in view of Trow et al., US 5,824,607 and Collins et al., U.S. Patent 5,556,501, Denholm et al., U.S. Patent 5,911,832 or Tozuka, U.S. Patent 4,771,730 as applied to claims 24-25, 27, 31, and 33-34 above, and further in view of Kumagai, U.S. Patent 5,916,455.

Kadomura, Trow et al., Collins et al., Denholm et al., and Tozuka are applied as above but do not expressly disclose a strike gas inlet. Kumagai discloses a strike gas inlet (see ignition chamber 30) whereby plasma is ignited and expelled into the inductively coupled plasma chamber (see fig. 1-2 and their descriptions). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the apparatus of Kadomura modified by Trow et al.,

Collins et al., and Denholm et al., or Tozuka so as to comprise a strike gas inlet because in such a way plasma will be more easily ignited for processing within the apparatus.

Response to Arguments

Applicant's arguments filed 4/2/09 have been fully considered but they are not persuasive. Applicant argues that Kadomura '268 does not teach a vertically extending coil and also does not teach that the loop antenna induces RF current into the plasma chamber. However, the examiner respectfully submits that when giving the claims their broadest reasonable interpretation, the loop antenna 22 can be considered to be a vertically extending coil as claimed since the coil clearly extends in a vertical direction. Furthermore, concerning the argument that when the loop antenna 22 is not connected to the RF power source it will not induce an RF current into the plasma chamber and excite and ionize a process gas, the examiner respectfully submits that even though the prior art reference is silent with respect to this limitation, this does not take away from the fact that inducing RF current into the plasma chamber is an inherent result of the loop antenna not being connected to RF power.

With respect to Kadomura '160, applicant argues that the solenoid coils 53a and 53b are not vertically extending coils. However, the examiner respectfully submits that when giving the claims their broadest reasonable interpretation, the coils 53a, 53b can be considered to be vertically extending coils as claimed since the coils clearly extend in a vertical direction. Furthermore, concerning the argument that when the coils are not

connected to the RF power source it will not induce an RF current into the plasma chamber and excite and ionize a process gas, the examiner respectfully submits that even though the prior art reference is silent with respect to this limitation, this does not take away from the fact that inducing RF current into the plasma chamber is an inherent result of the loop antenna not being connected to the power source.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Luz L. Alejandro whose telephone number is 571-272-1430. The examiner can normally be reached on Monday to Thursday from 7:30 to 6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Luz L. Alejandro/
Primary Examiner, Art Unit 1792

June 7, 2009